

WHAT IS CLAIMED IS:

1. A trace oxygen measuring apparatus being provided with at least one limiting current type oxygen sensor having
5 an oxygen pump cell comprising an oxygen ion conductive solid electrolyte and a metal electrode, and a concentration detecting sensor, said limiting current type as a blank sensor or a measure sensor; wherein:

when said limiting current type oxygen sensor serves as a blank sensor, an oxygen concentration in a deoxidizing measuring gas obtained by feeding a measurement gas through an oxygen remover is measured by means of pump current of a limiting current type sensor:

when said limiting current type oxygen sensor serves as a measure sensor, an oxygen concentration in the measurement gas is measured by means of pump current of the limiting current type sensor; and

said apparatus has a mechanism for calculating difference in pump current between the measure sensor and
20 the blank sensor as an oxygen concentration contained in said measurement gas.

2. A trace oxygen measuring apparatus according to claim 1, which is provided with a branching mechanism for
25 branching said measurement gas; wherein:

a measurement gas passes through said oxygen remover by action of said branching mechanism and is then fed to said blank sensor; and

another measurement gas is directly fed to said measure
5 sensor by action of said branching mechanism.

3. A trace oxygen measuring apparatus according to
claim 1; wherein there is provided a switching mechanism for
measuring values of pump current as a blank sensor and a
measure sensor; said mechanism capable of switching over
time wise in the following manner;

a deoxidized measurement gas after passing through said
oxygen remover is fed during a period of time, and

said measurement gas is fed directly to said oxygen
15 sensor during another period of time.

4. A trace oxygen measuring apparatus according to
claim 1, wherein there are provided two limiting current
type oxygen sensors each having an oxygen pump cell
20 comprising said oxygen ion conductive solid electrolyte and
a metal electrode, and a concentration detecting cell, and
wherein one of the limiting current type oxygen sensor is
used as a blank sensor, and an other limiting current type
oxygen sensor is used as a measure sensor.

5. A trace oxygen measuring apparatus according to
claim 1, wherein there is provided a feedback controller for
controlling an electromotive force of the concentration
detecting cell by feeding or discharging oxygen with current
5 energizing the oxygen pump of said limiting current type
oxygen sensor at a prescribed set voltage.

6. A trace oxygen measuring apparatus according to
claim 5, wherein the set voltage of the electromotive force
10 of the concentration detecting cell in said feedback
controller is controlled to a voltage of up to 240 mV which
corresponds to an oxygen concentration range of at least 2
ppm ensuring followup of the electromotive force - oxygen
concentration characteristics of the concentration detecting
15 cell to Nernst's formula.

7. A trace oxygen measuring apparatus according to
claim 5, further comprising a special air duct communicating
with open air as an oxygen source necessary for feedback
20 control effected by said feedback controller.

8. A trace oxygen measuring apparatus according to
claim 1, wherein:

25 said oxygen sensor is formed with a plurality of solid
electrolyte layers; and

a first air duct, a second air duct and a measuring duct defined by said plurality of solid electrolyte layers;

said measuring duct has an oxygen discharge electrode and a concentration detecting electrode;

5 an oxygen pump cell formed of an oxygen feed electrode formed in said first air duct, and an oxygen discharge electrode formed in said measuring duct via the solid electrolyte layers formed between said first air duct and said measuring duct; and

10 a concentration detecting cell having an air reference electrode formed in said second air duct and a concentration detecting electrode formed in said measuring duct, via the solid electrolyte layers formed between said second air duct and said measuring duct; and

15 a mechanism for measuring the oxygen concentration in the measurement gas by measuring the oxygen pump current during feedback control through operation of the oxygen pump so that the electromotive force of said concentration detecting cell becomes a prescribed set voltage.

20

9. A trace oxygen measuring apparatus according to claim 8, wherein, in said oxygen sensor, the electrode present in the first air duct is an air reference electrode; the electrode opposite thereto is a concentration detecting electrode; the electrode present in the second air duct is

25

an oxygen feed electrode; and the electrode opposite thereto
is an oxygen discharge electrode.

10. A method of measuring the trace oxygen

5 concentration in a measurement gas containing trace oxygen
by means of an oxygen sensor, comprising the steps of:

using said oxygen sensor, wherein:

said oxygen sensor is formed with a plurality of solid
electrolyte layers; and

10 a first air duct, a second air duct and a measuring
duct defined by said plurality of solid electrolyte layers;

said measuring duct has an oxygen discharge electrode
and a concentration detecting electrode;

15 an oxygen pump cell formed of an oxygen feed electrode
formed in said first air duct, and an oxygen discharge
electrode formed in said measuring duct via the solid
electrolyte layers formed between said first air duct and
said measuring duct;

a concentration detecting cell having an air reference
20 electrode formed in said second air duct and a concentration
detecting electrode formed in said measuring duct, via the
solid electrode layers formed between said second air duct
and said measuring duct; and

25 a mechanism for measuring the oxygen concentration in
the measurement gas by measuring the oxygen pump current

during feedback control through operation of the oxygen pump so that the electromotive force of said concentration detecting cell becomes a prescribed set voltage;

controlling the electromotive force set voltage of the
5 concentration detecting cell in feedback control of said oxygen sensor to a prescribed voltage of up to 240 V which corresponds to an oxygen concentration range of at least 2 ppm ensuring followup of Nernst's formula of the concentration detecting cell electromotive force - oxygen concentration characteristics; and

feeding oxygen necessary for achieving a set oxygen concentration in the measuring duct from a special oxygen feed air duct communicating with open air.

15 11. A method of measuring the trace oxygen concentration in a measurement gas containing a combustible gas and trace oxygen by means of an oxygen sensor, comprising the steps of:

using said oxygen sensor, wherein:

20 said oxygen sensor is formed with a plurality of solid electrolyte layers; and

a first air duct, a second air duct and a measuring duct defined by said plurality of solid electrolyte layers;

said measuring duct has an oxygen discharge electrode
25 and a concentration detecting electrode;

an oxygen pump cell formed of an oxygen feed electrode formed in said first air duct, and an oxygen discharge electrode formed in said measuring duct via the solid electrolyte layers formed between said first air duct and
5 said measuring duct; and

a concentration detecting cell having an air reference electrode formed in said second air duct and a concentration detecting electrode formed in said measuring duct, via the solid electrode layers formed between said second air duct and said measuring duct;

using at least one such oxygen sensor having a mechanism for measuring the oxygen concentration in the measurement gas by measuring the oxygen pump current during feedback control through operation of the oxygen pump so
15 that the electromotive force of said concentration detecting cell becomes a prescribed set voltage;

measuring the oxygen concentration of the measurement gas from which oxygen has been removed through the oxygen remover by means of the pump current value of the oxygen
20 sensor; and

calculating the difference between the first measured oxygen pump current and the second measured oxygen pump current, as the oxygen concentration in the measurement gas,
25 by measuring the oxygen concentration of the measurement gas, not having passed through the oxygen remover, by means of

the pump current of the oxygen sensor.

12. A method of measuring trace oxygen according to
claim 11, comprising the step of feeding the measurement gas
5 through the oxygen remover or not through the same by
operating a switching mechanism, to the oxygen sensor.

10 13. A method of measuring trace oxygen according to
claim 11, comprising the steps of:

15 using two oxygen sensors;
measuring the oxygen concentration of the measurement
gas from which oxygen has been removed through the oxygen
remover by means of pump current of the first oxygen sensor;
and

20 calculating, as the oxygen concentration in the
measurement gas, the difference between pump current of the
first oxygen sensor and pump current of the second oxygen
sensor by measuring the oxygen concentration of the
measurement gas, not having passed through the oxygen
remover, by means of pump current of the second oxygen
sensor.

25 14. A device for generating oxygen in a trace amount
comprising

a plurality of solid electrolyte layers;

- an oxygen feed duct comprising a first air duct which
is a vacancy defined by the solid electrolyte layers forming
three continuous layers at least at an end thereof and an
electrode feed electrode formed in the first air duct; and
5 an oxygen pump cell comprising an oxygen discharge
electrode provided on the surface of the upper solid
electrolyte layer forming said three layers, and an oxygen
feed electrode formed in said first air duct;
wherein a constant current source/controller is
10 arranged between the oxygen discharge electrode and the
oxygen feed electrode so that prescribed current flows
therebetween.
15. A device for generating oxygen in a trace amount
15 according to claim 14, comprising
a second air duct and an air reference electrode
provided in said second air duct;
wherein said air reference electrode forms a detecting
cell which monitors a decrease in oxygen concentration
20 caused by oxygen feed in the oxygen feed duct through a
change in electromotive force by measuring electromotive
force between the air reference electrode and the oxygen
feed electrode in said oxygen feed duct.
- 25 16. A trace oxygen generating apparatus comprising a

plurality of solid electrolyte layers comprising:

an oxygen feed duct comprising a first air duct, which
is a vacancy defined by solid electrolyte layers forming
three continuous layers at least at an end thereof, and an
oxygen feed electrode formed in said first air duct; and

an oxygen pump cell comprising an oxygen discharge
electrode provided on the surface of an upper layer of the
solid electrolyte layers forming said three layers, and an
oxygen feed electrode formed in said first air duct;

wherein a constant current source/controller is
arranged between the oxygen discharge electrode and the
oxygen feed electrode so that prescribed current flows
therebetween.

17. A trace oxygen generating apparatus according to
claim 16, comprising

a second air duct and an air reference electrode
provided in said second air duct in addition to said first
air duct;

wherein said air reference electrode forms a detecting
cell which monitors a decrease in oxygen concentration
caused by oxygen feed in the oxygen feed duct through a
change in electromotive force by measuring electromotive
force between the air reference electrode and the oxygen
feed electrode in said oxygen feed duct.

18. A method of generating trace oxygen comprising the steps of:

feeding constant current to the oxygen pump cell comprising an oxygen feed electrode and an oxygen discharge electrode by activating a constant current source/controller so as to generate prescribed oxygen and operating an oxygen pump;

sending a gas from a carrier gas source to the oxygen pump;

receiving oxygen fed from the oxygen pump; and feeding a carrier gas added with the resultant trace oxygen in a prescribed amount to a necessary point.

19. A method of generating trace oxygen comprising the steps of:

feeding constant current to an oxygen pump cell comprising an oxygen feed electrode and an oxygen discharge electrode by operating a constant current source/controller so as to generate prescribed oxygen, and operating an oxygen pump;

sending zero gas which is a carrier gas from a carrier gas source from which oxygen has been removed through an oxygen remover using a deoxidizer;

receiving oxygen fed from the oxygen pump; and

feeding a gas containing trace oxygen in a resultant

prescribed amount to places requiring such gas.

20. A method of generating trace oxygen comprising the steps of:

- 5 operating a constant current source/controller, and operating an oxygen pump by feeding constant current to an oxygen pump cell comprising an oxygen feed electrode and an oxygen discharge electrode so as to generate prescribed oxygen;
- 10 adding oxygen in a slight amount to a carrier gas from a carrier gas source, heating the resultant mixture to burn the combustible fraction, removing oxygen in an oxygen remover using a deoxidizer or the like, and sending a zero gas from which the combustible fraction and oxygen have been removed to the oxygen pump side;
- 15 receiving oxygen fed from the oxygen pump; and feeding a gas containing trace oxygen in a resultant prescribed amount to places requiring such gas.